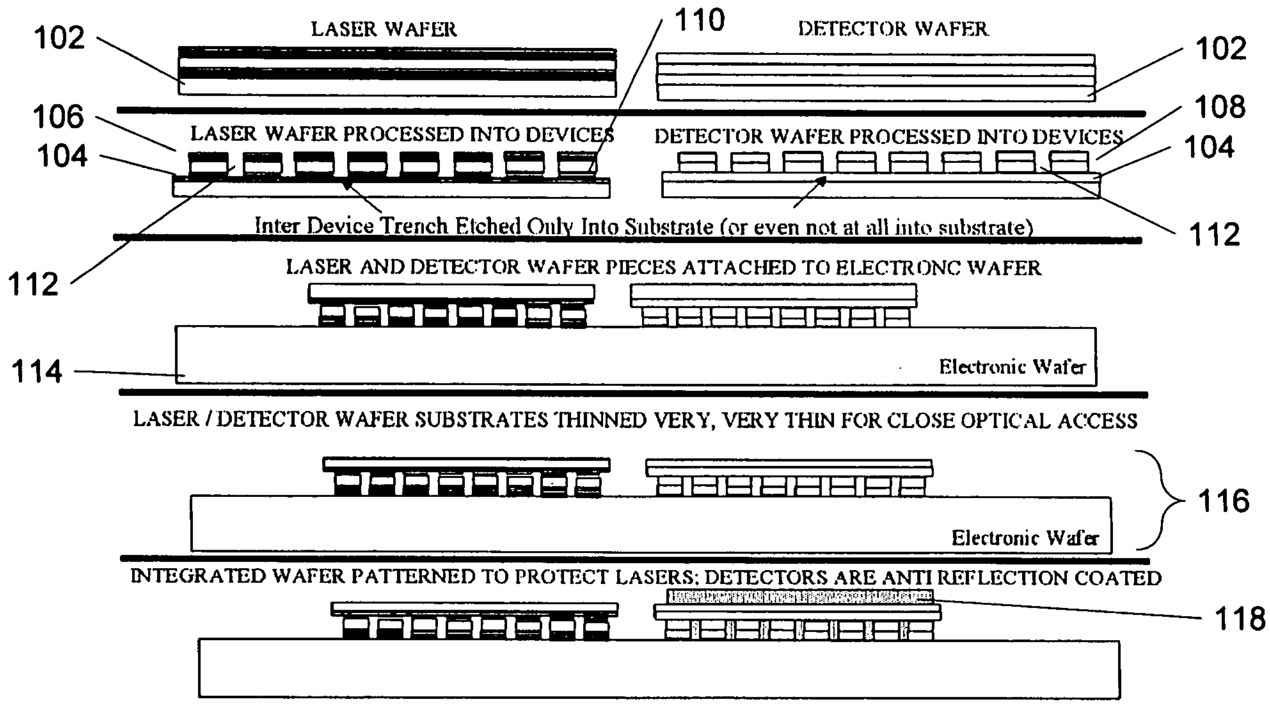

LASER WAFER
DETECTOR WAFER
102
110
102
106
108
104
104
LASER WAFER PROCESSED INTO DEVICES
DETECTOR WAFER PROCESSED INTO DEVICES
Inter Device Trench Etched Only Into Substrate (or even not at all into substrate)
112
112
LASER AND DETECTOR WAFER PIECES ATTACHED TO ELECTRONC WAFER
114
Electronic Wafer
LASER / DETECTOR WAFER SUBSTRATES THINNED VERY, VERY THIN FOR CLOSE OPTICAL ACCESS
116
Electronic Wafer
INTEGRATED WAFER PATTERNED TO PROTECT LASERS; DETECTORS ARE ANTI REFLECTION COATED
118

FIG. 1

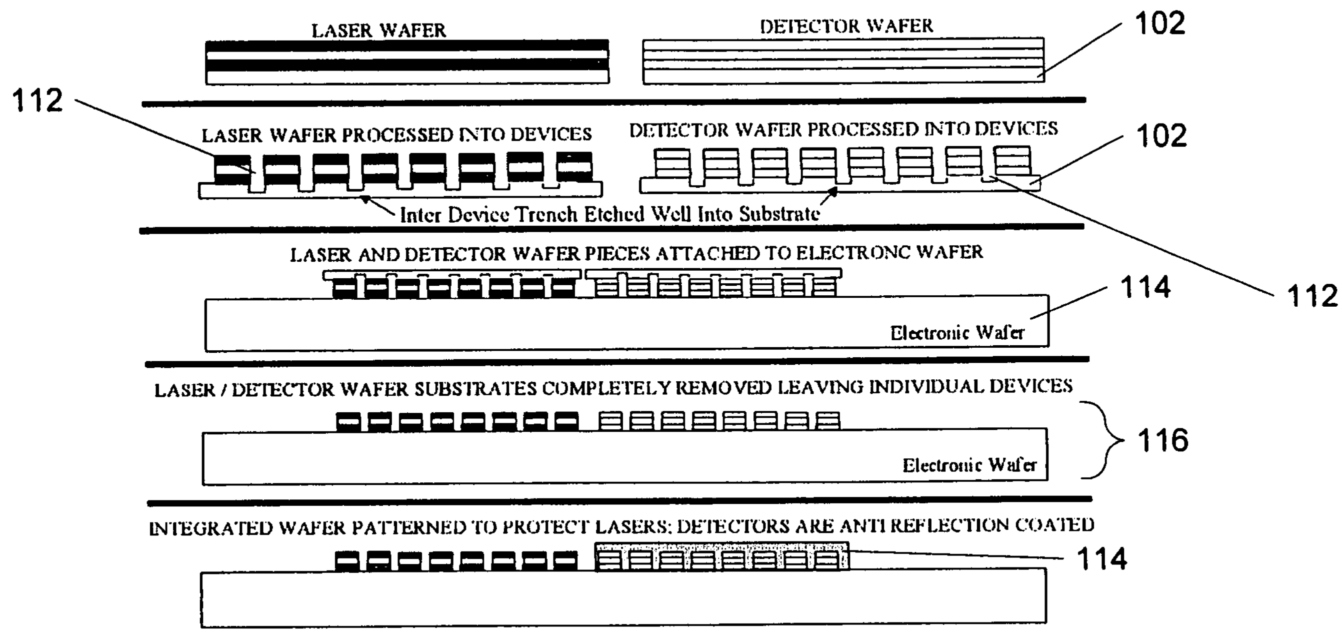

LASER WAFER
DETECTOR WAFER
102
112
LASER WAFER PROCESSED INTO DEVICES
DETECTOR WAFER PROCESSED INTO DEVICES
102
Inter Device Trench Etched Well Into Substrate
LASER AND DETECTOR WAFER PIECES ATTACHED TO ELECTRONC WAFER
114
112
Electronic Wafer
LASER / DETECTOR WAFER SUBSTRATES COMPLETELY REMOVED LEAVING INDIVIDUAL DEVICES
116
Electronic Wafer
INTEGRATED WAFER PATTERNED TO PROTECT LASERS; DETECTORS ARE ANTI REFLECTION COATED
114

FIG. 2

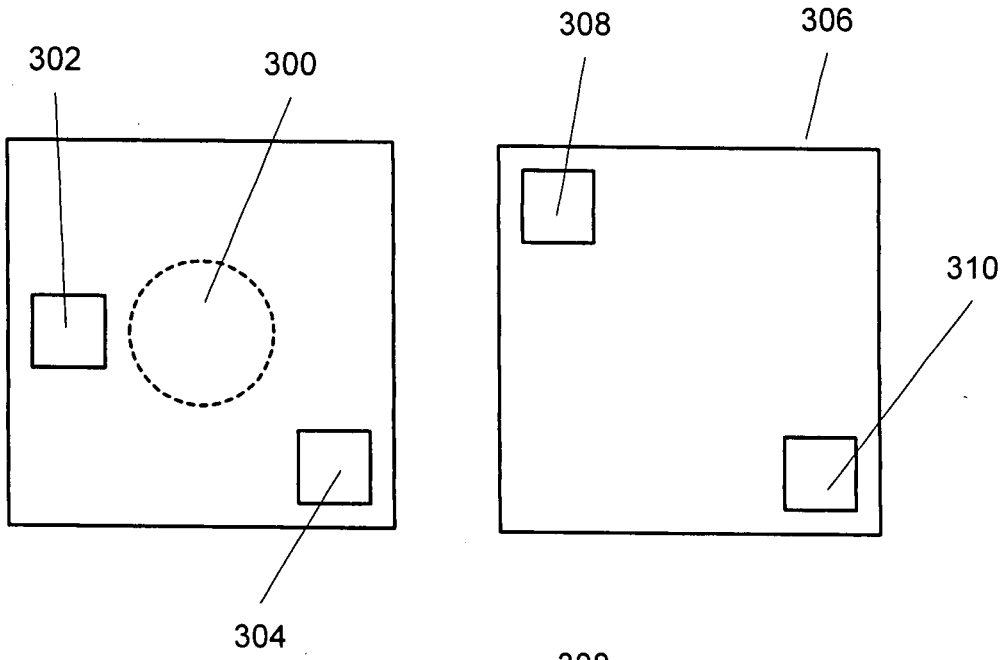


FIG. 3

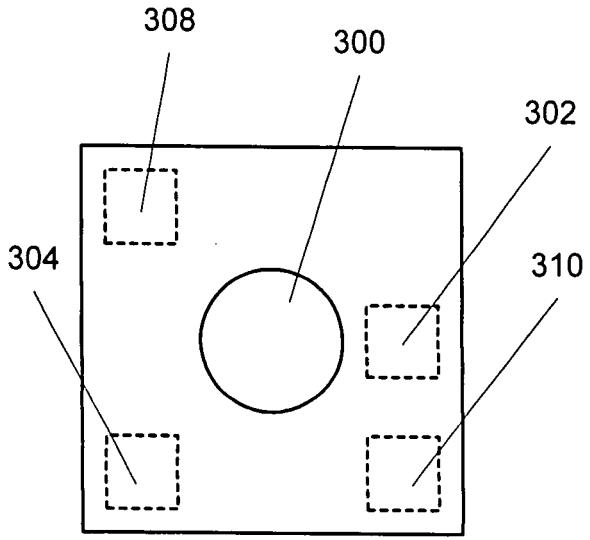


FIG. 4

FOO250" 89FZ060O

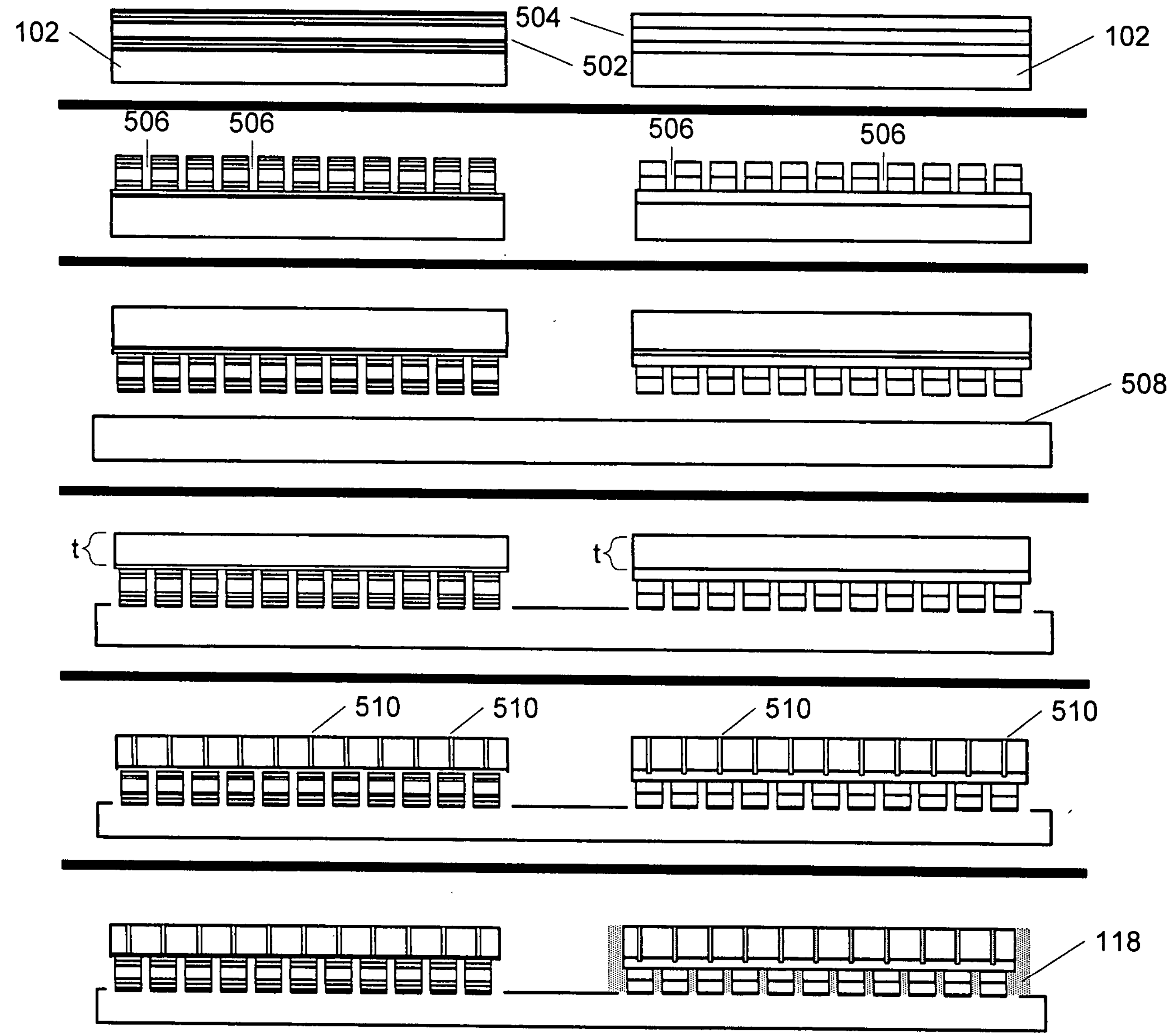


FIG. 5

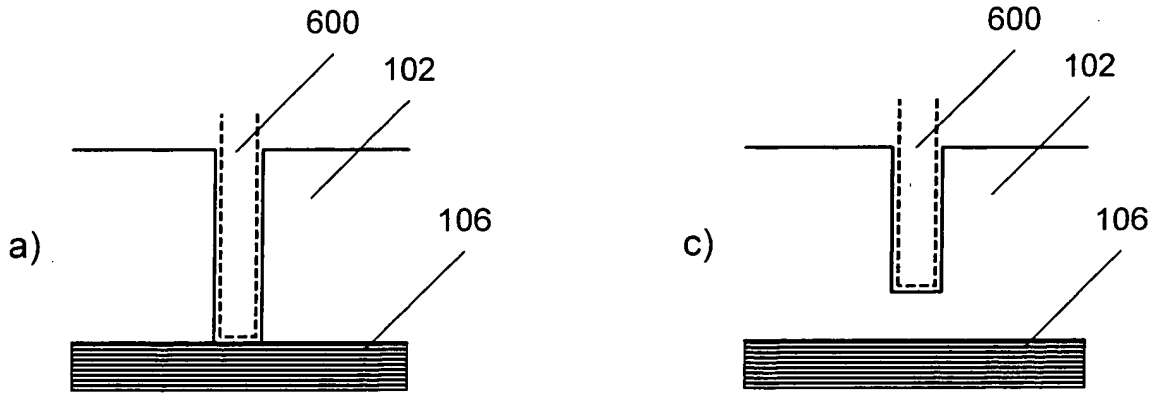
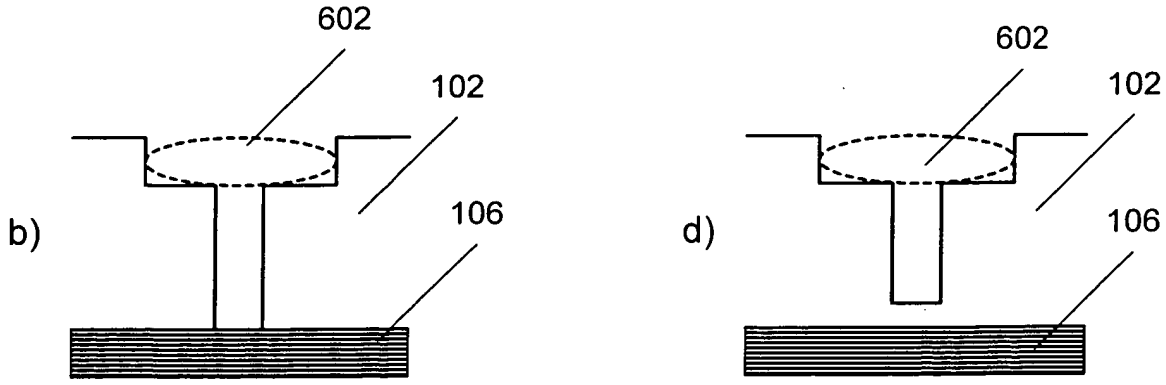


FIG. 6



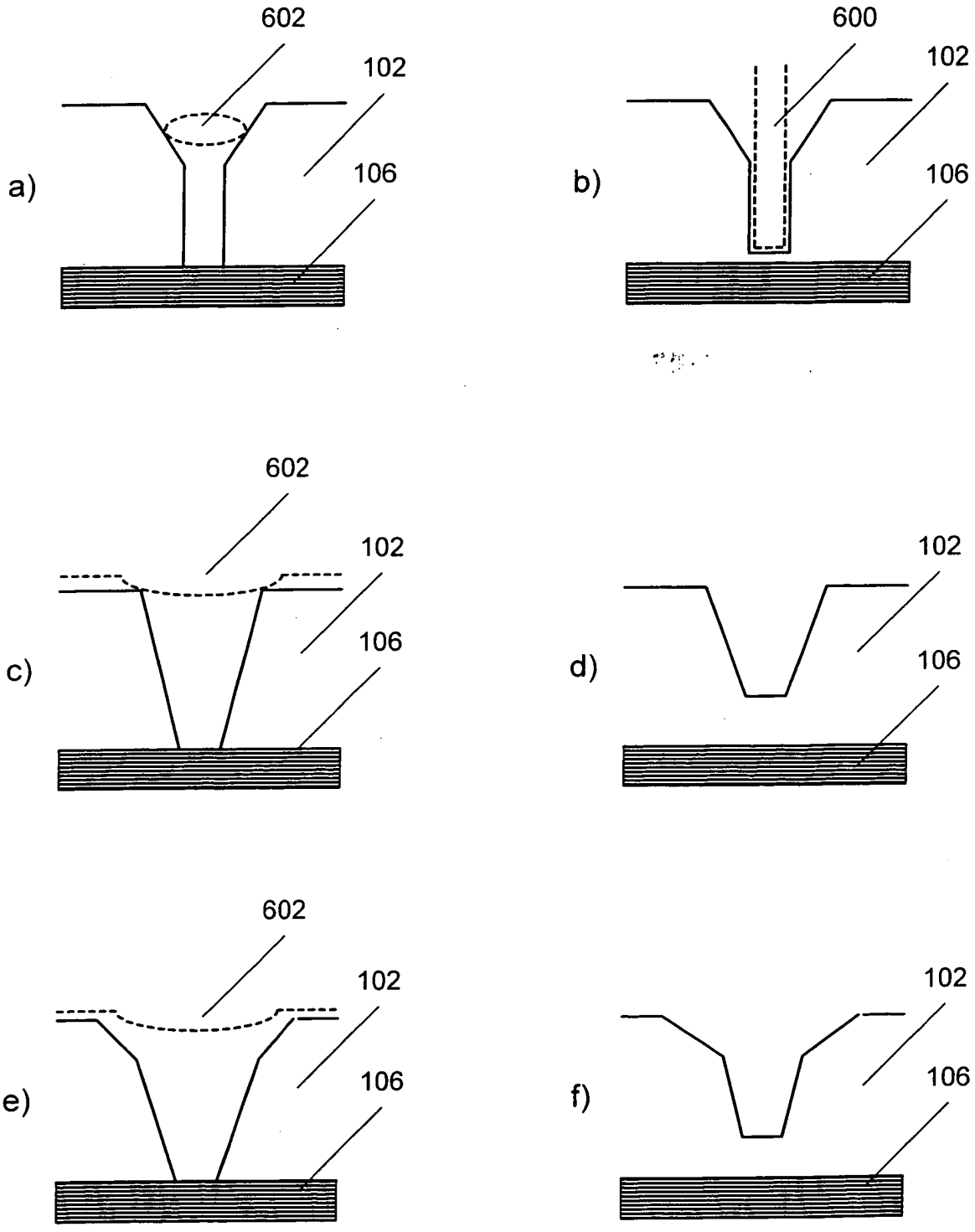

602
102
106
a)
600
102
106
b)
602
102
106
c)
102
106
d)
602
102
106
e)
102
106
f)

FIG. 7

FIG. 8

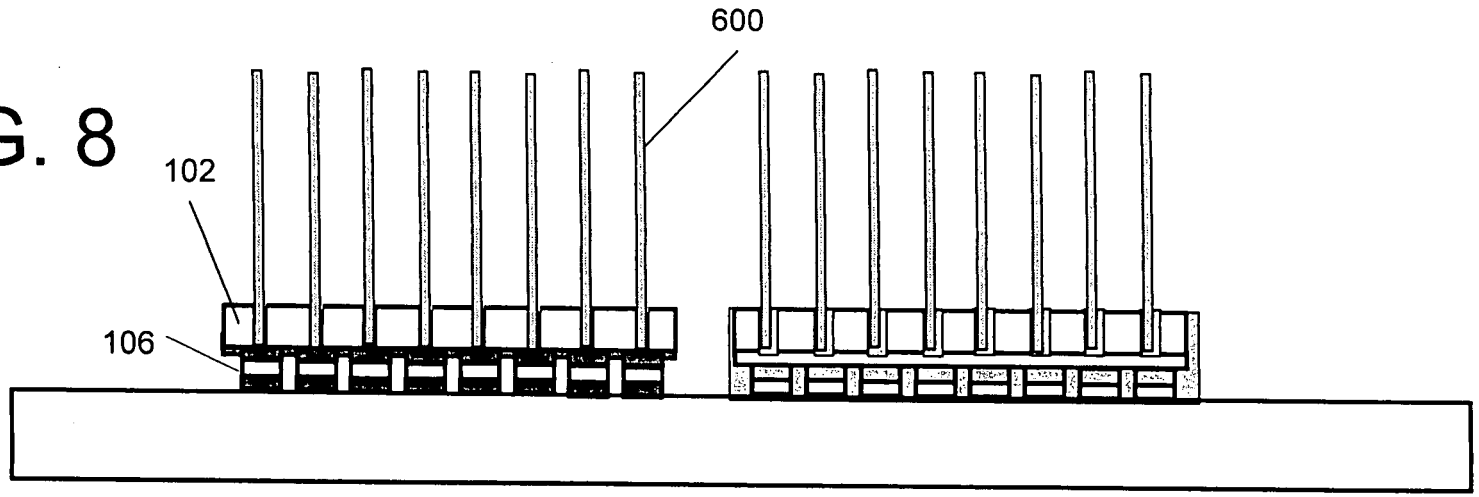
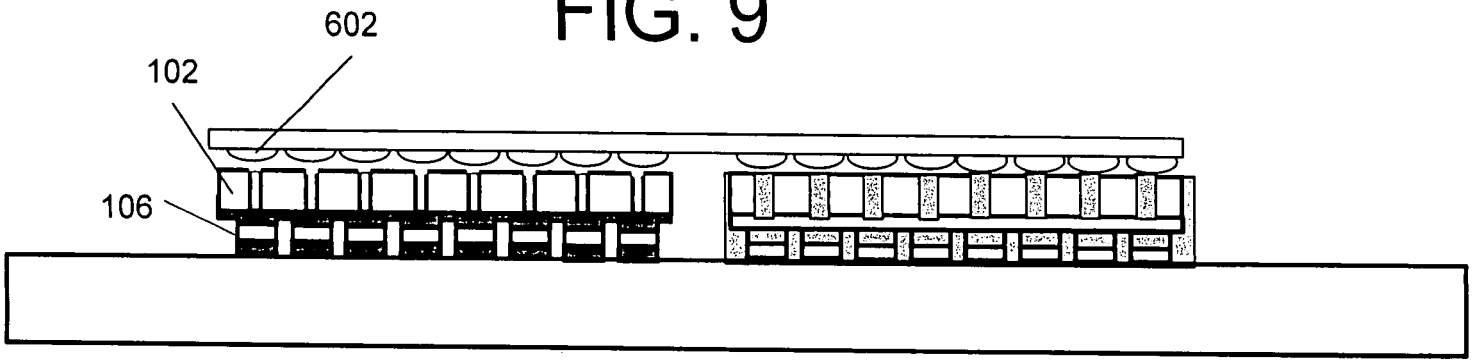


FIG. 9



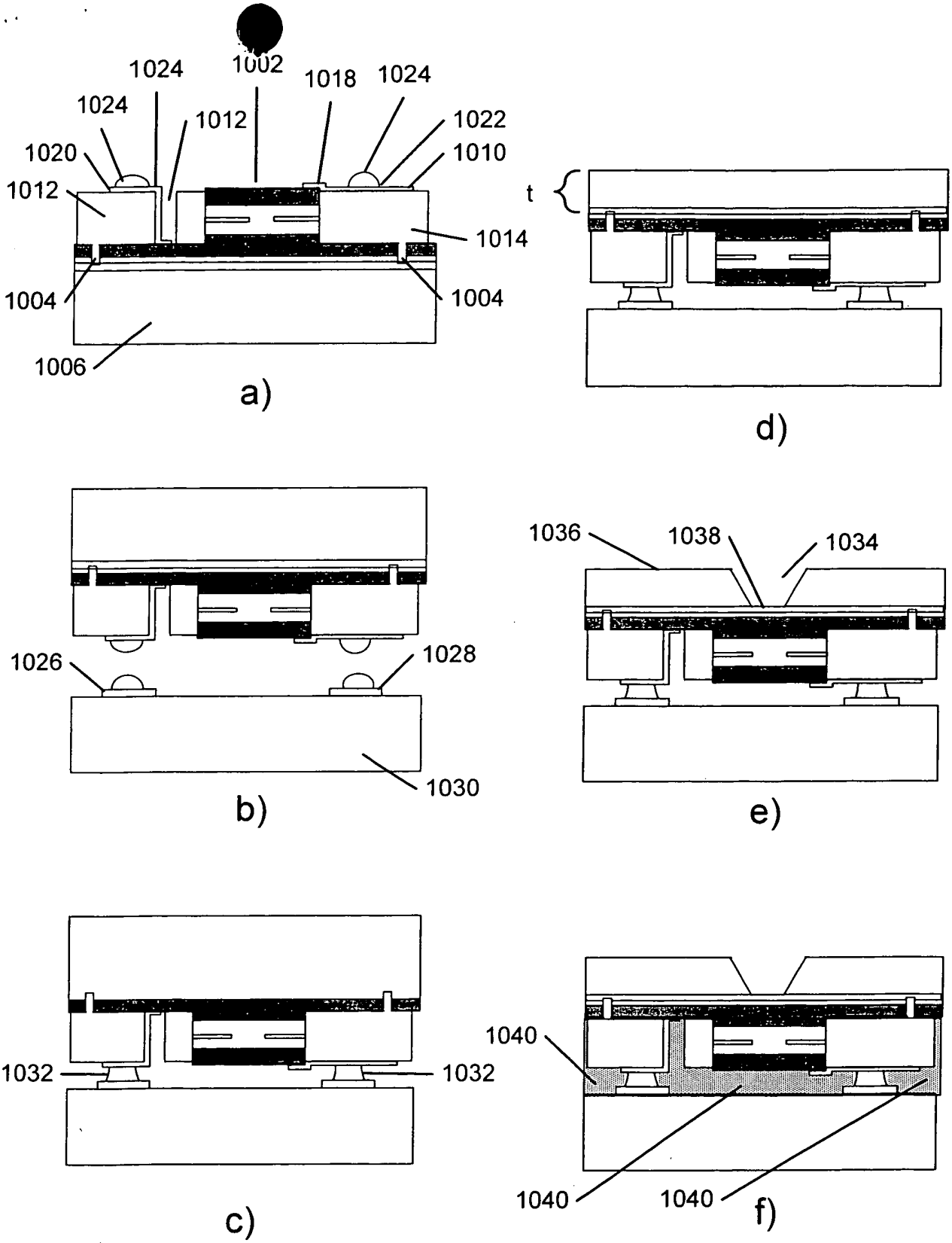
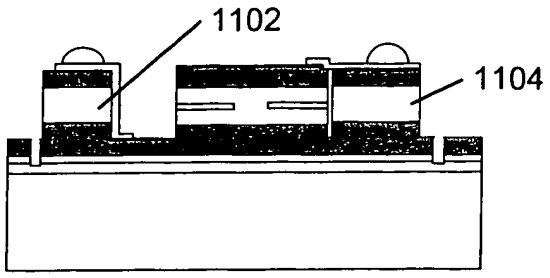
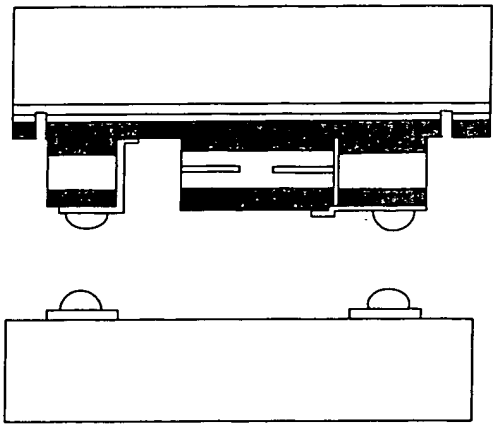

1024
1002
1018
1024
1024
1012
1022
1020
1010
1012
1014
1004
1004
1006
a)
t
d)
1026
1028
1030
b)
1036
1038
1034
e)
1032
1032
c)
1040
1040
1040
f)

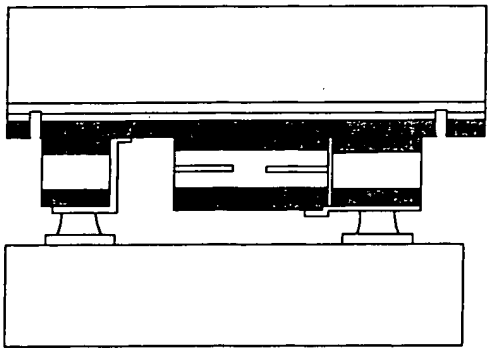
FIG. 10



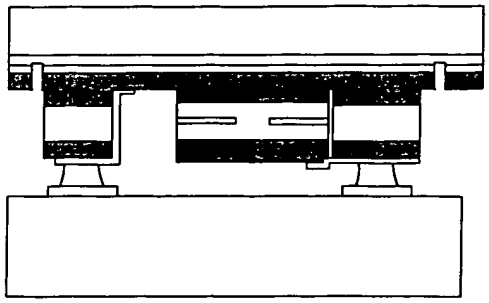
a)



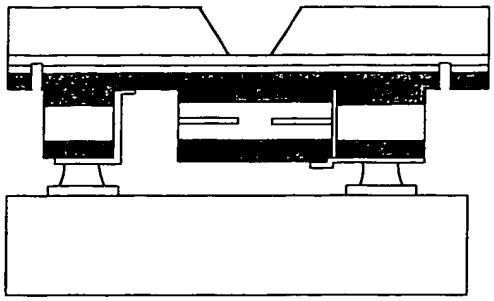
b)



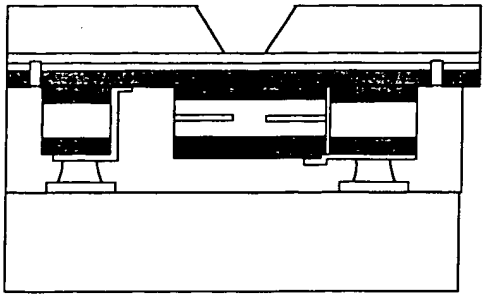
c)



d)



e)



f)

FIG. 11

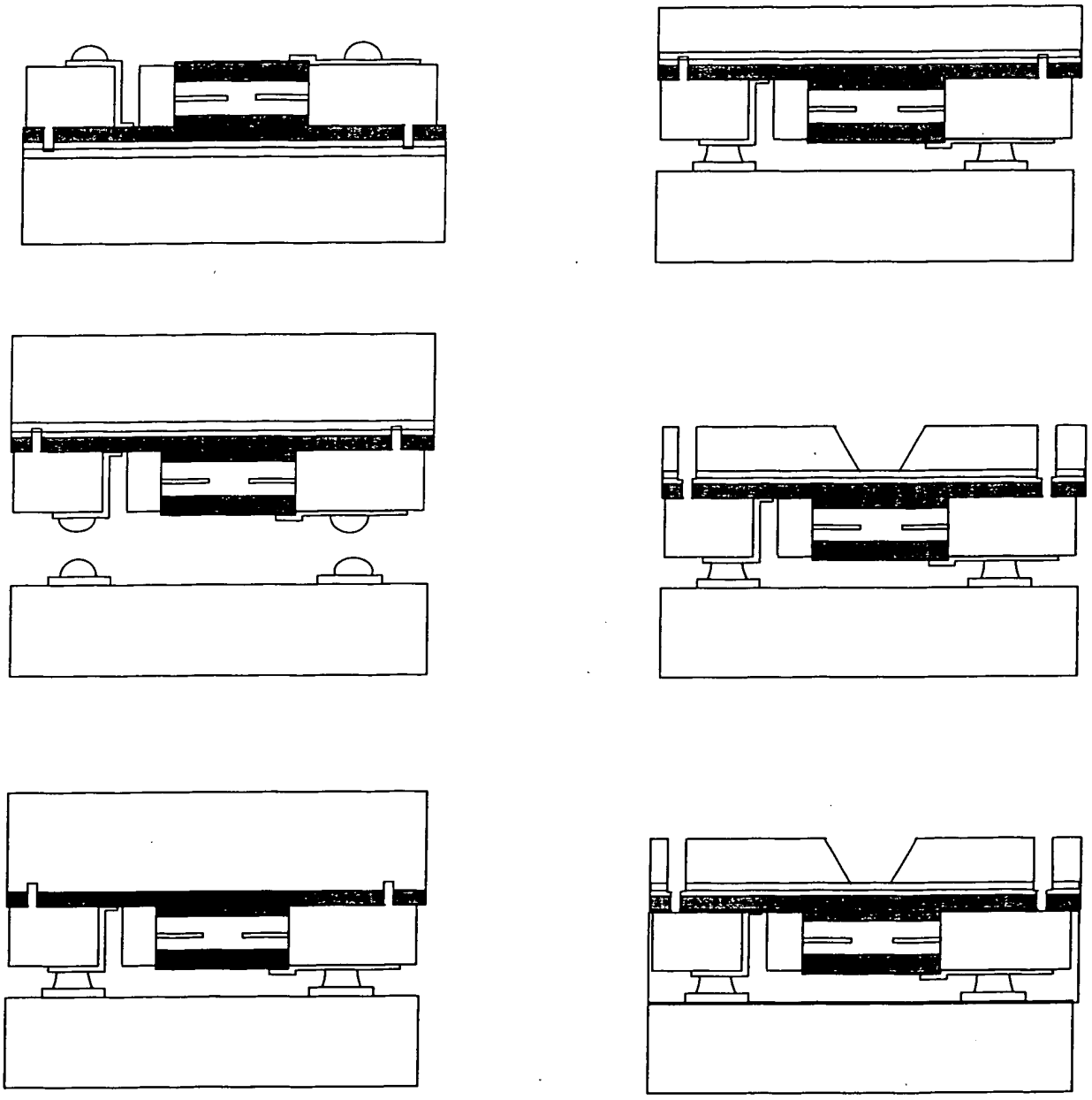
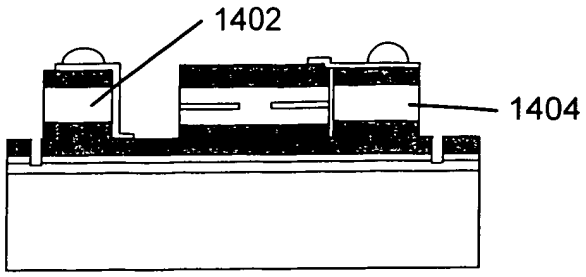
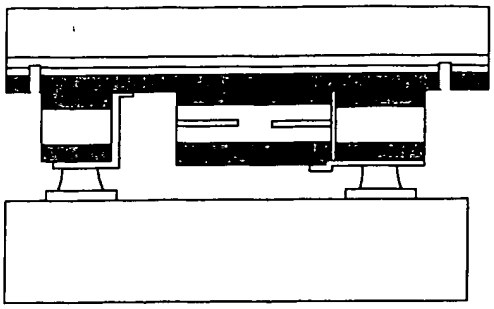


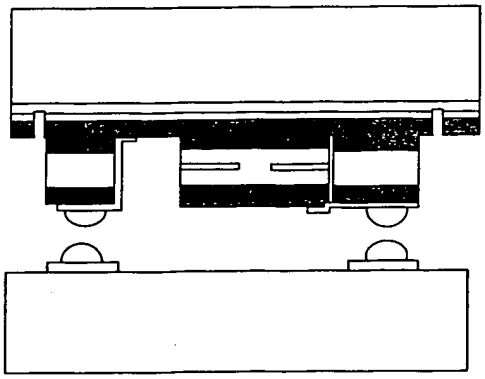
FIG. 12



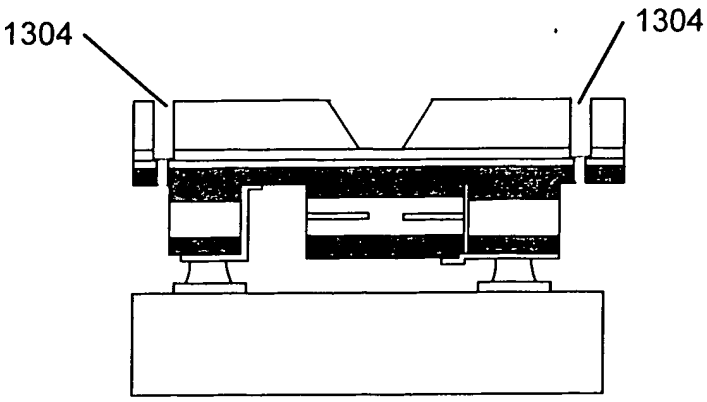
a)



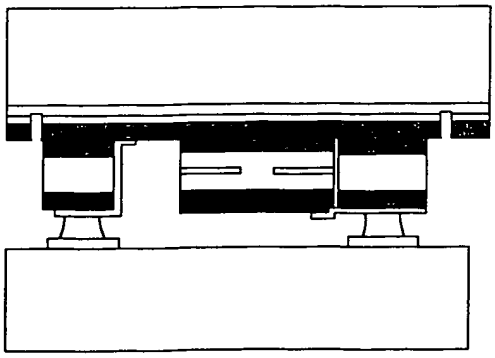
d)



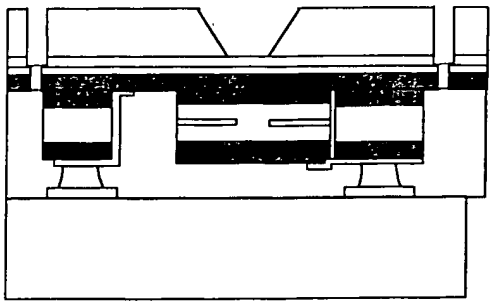
b)



e)



c)



f)

FIG. 14

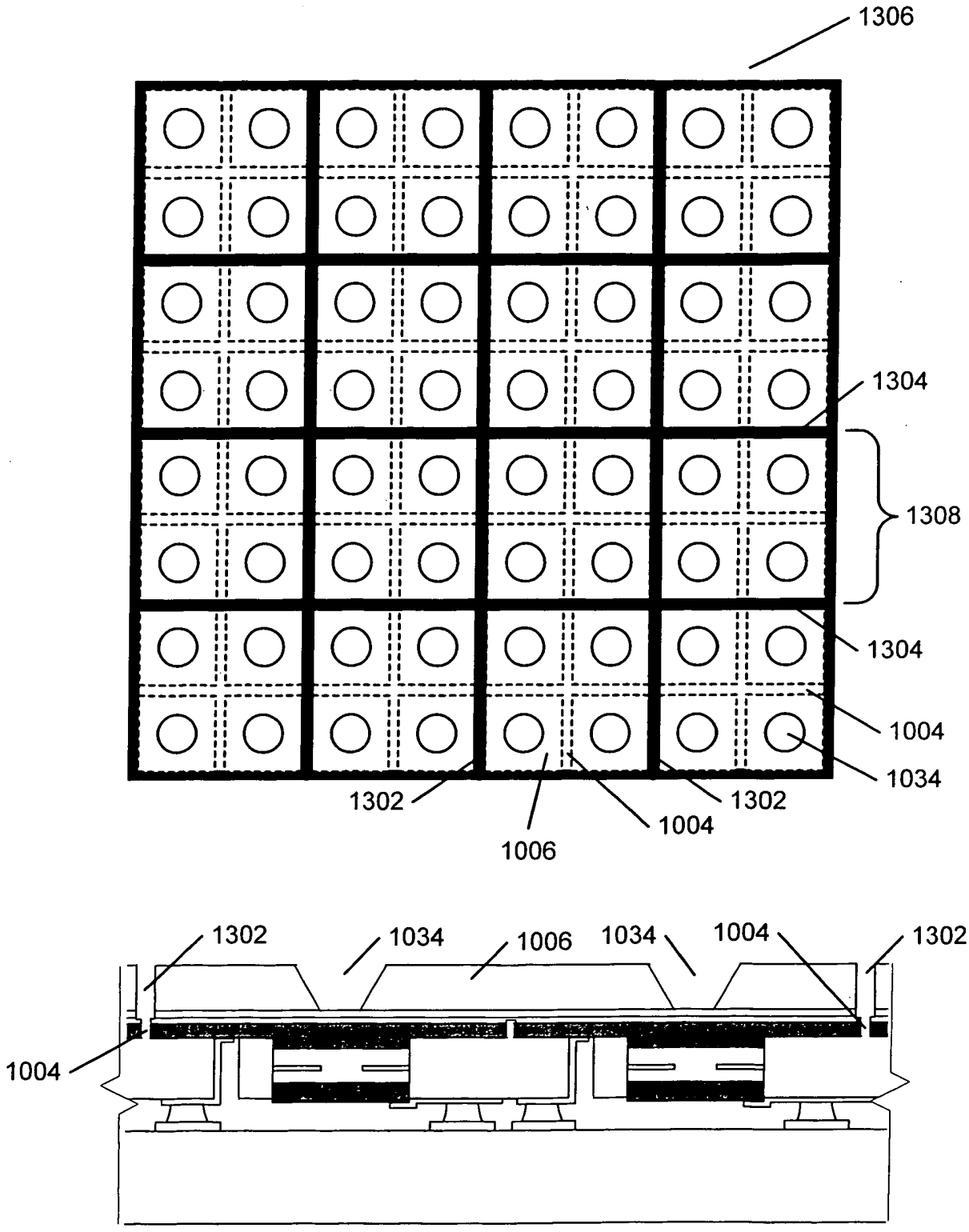
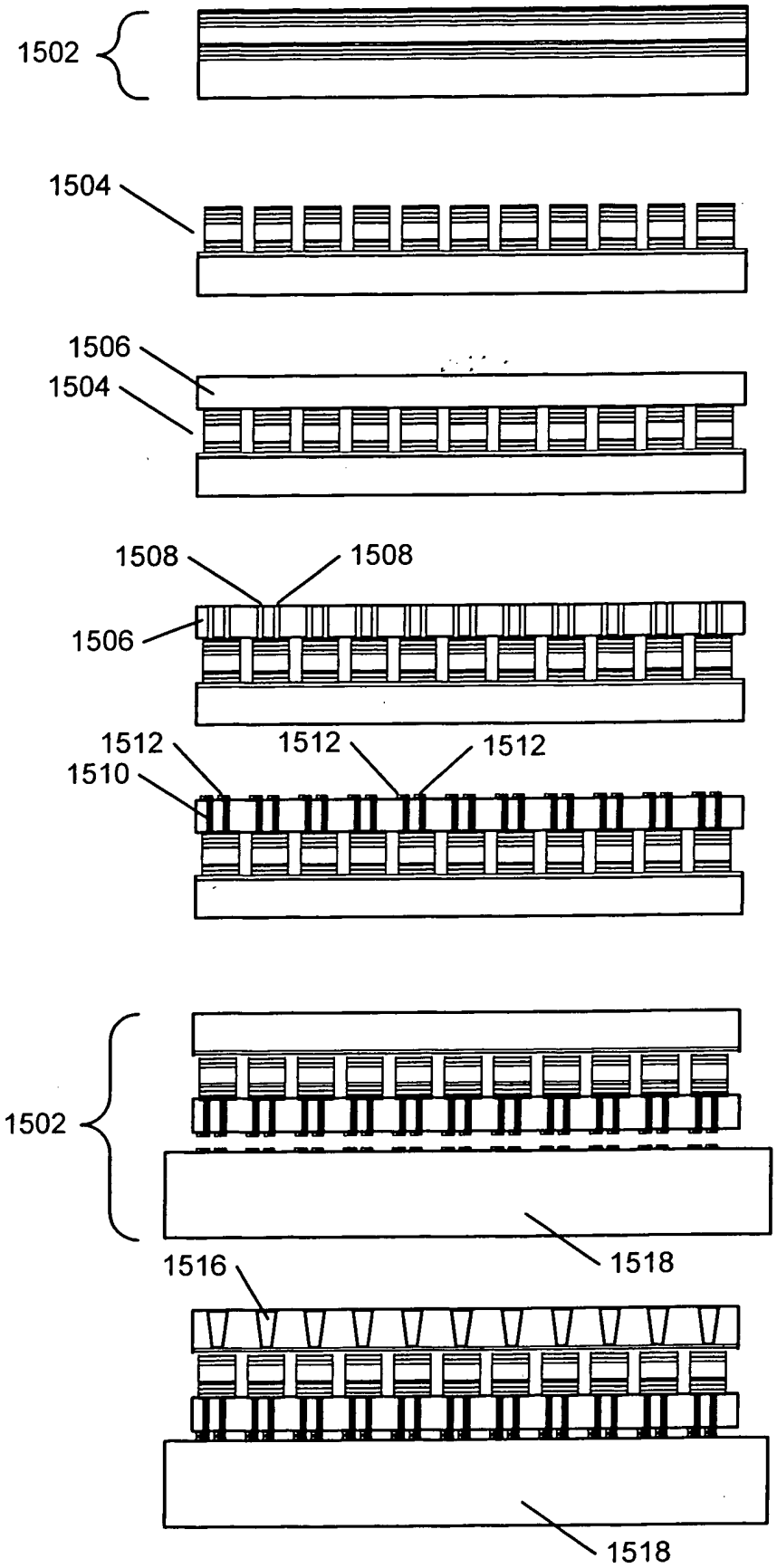

1306
1304
1308
1304
1004
1034
1302
1006
1004
1302
1302
1034
1006
1034
1004
1302
1004

FIG. 13

FIG. 15


1502
1504
1506
1504
1508
1508
1506
1512
1512
1512
1510
1502
1518
1516
1518

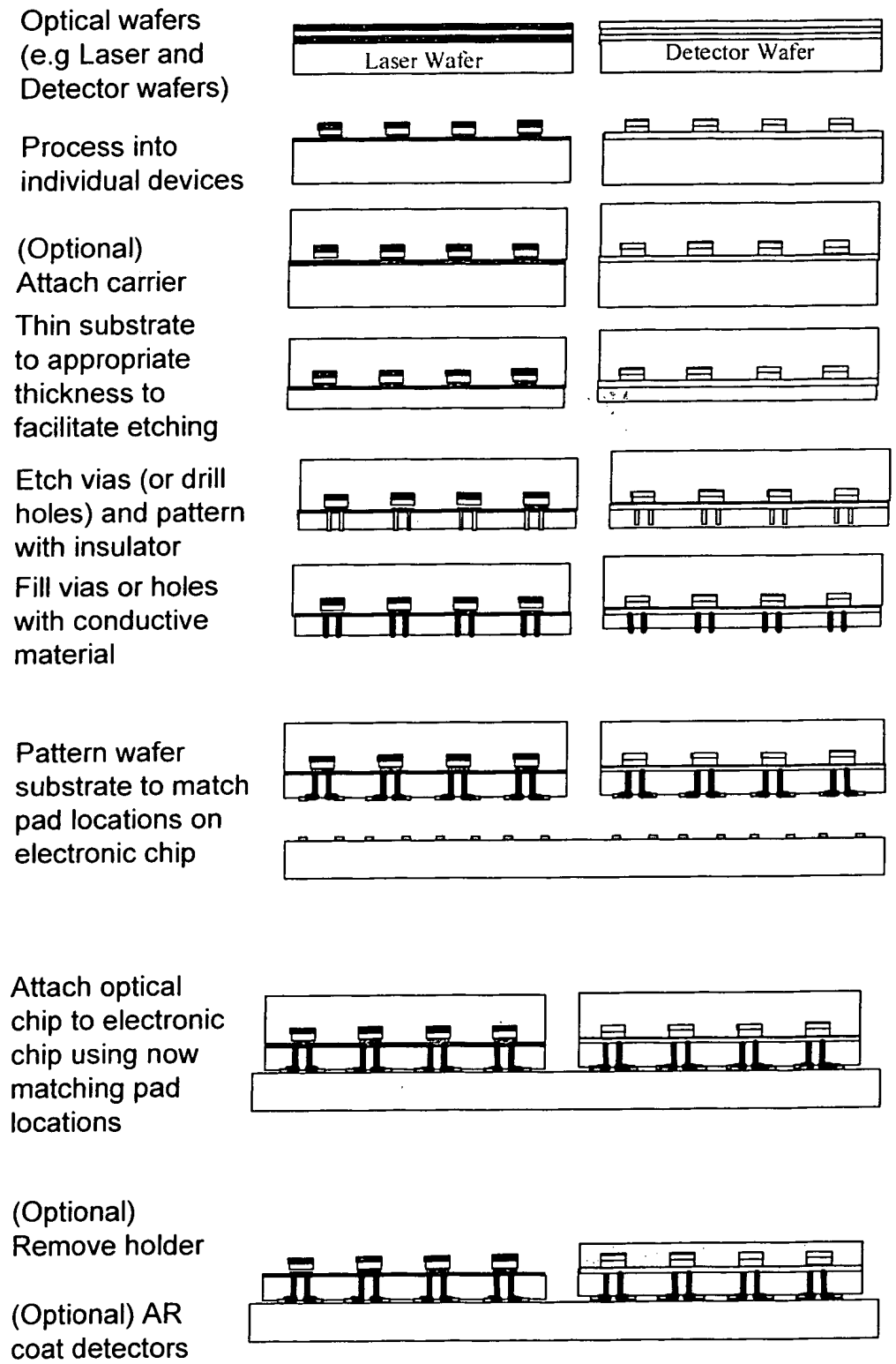
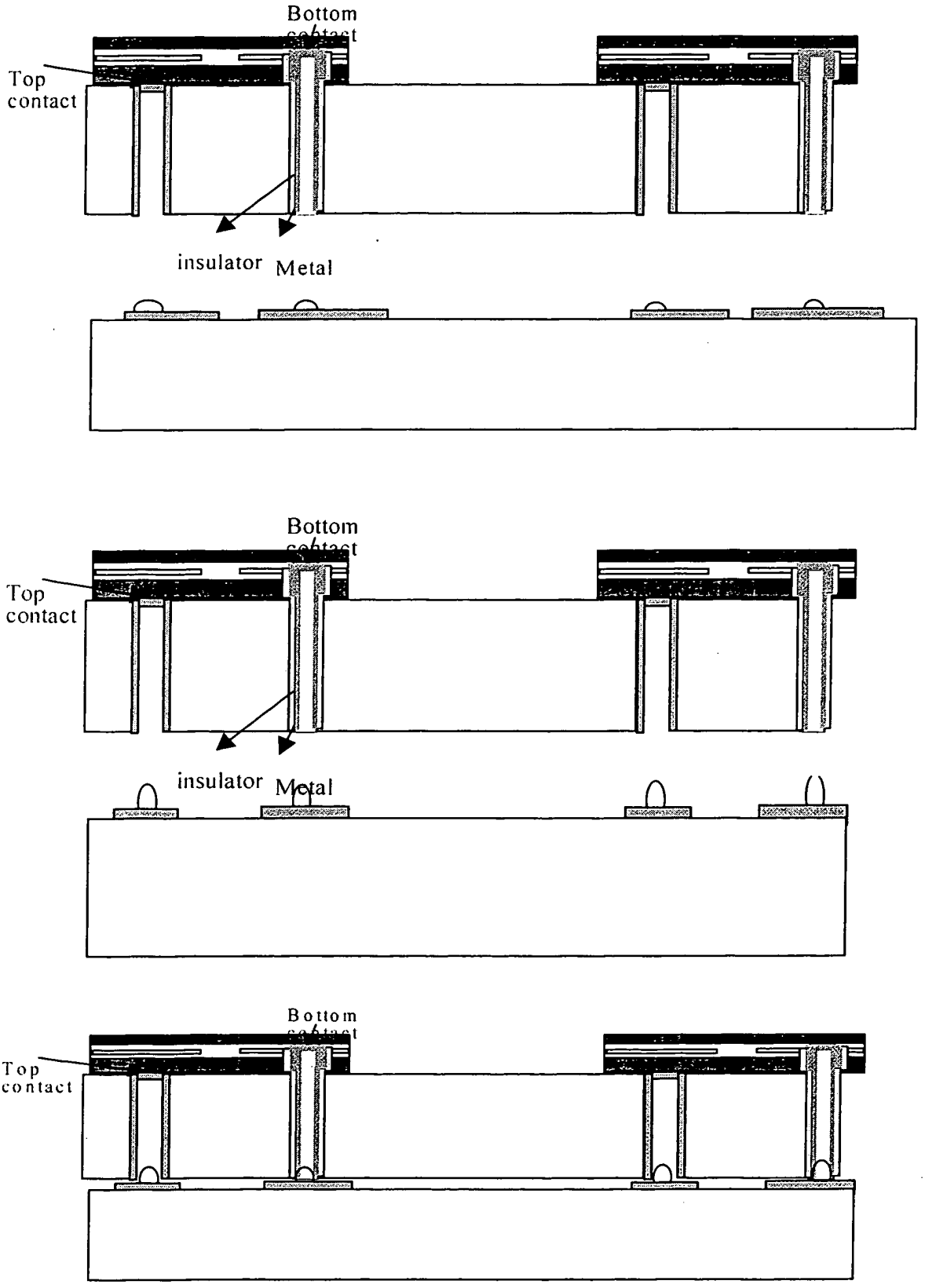

Optical wafers (e.g Laser and Detector wafers)
Laser Wafer
Detector Wafer
Process into individual devices
(Optional) Attach carrier
Thin substrate to appropriate thickness to facilitate etching
Etch vias (or drill holes) and pattern with insulator
Fill vias or holes with conductive material
Pattern wafer substrate to match pad locations on electronic chip
Attach optical chip to electronic chip using now matching pad locations
(Optional) Remove holder
(Optional) AR coat detectors

FIG. 16A

FIG. 16B


Bottom contact
Top contact
insulator
Metal
Bottom contact
Top contact
insulator
Metal
Bottom contact
Top contact

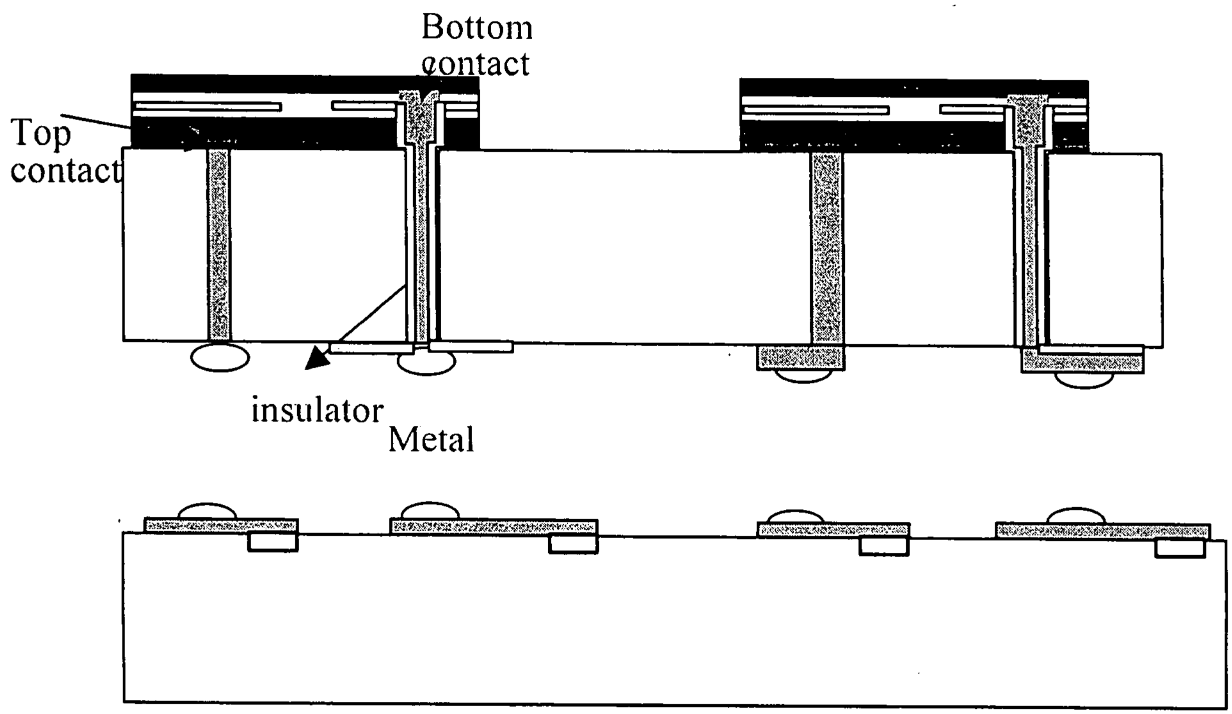


FIG. 16C

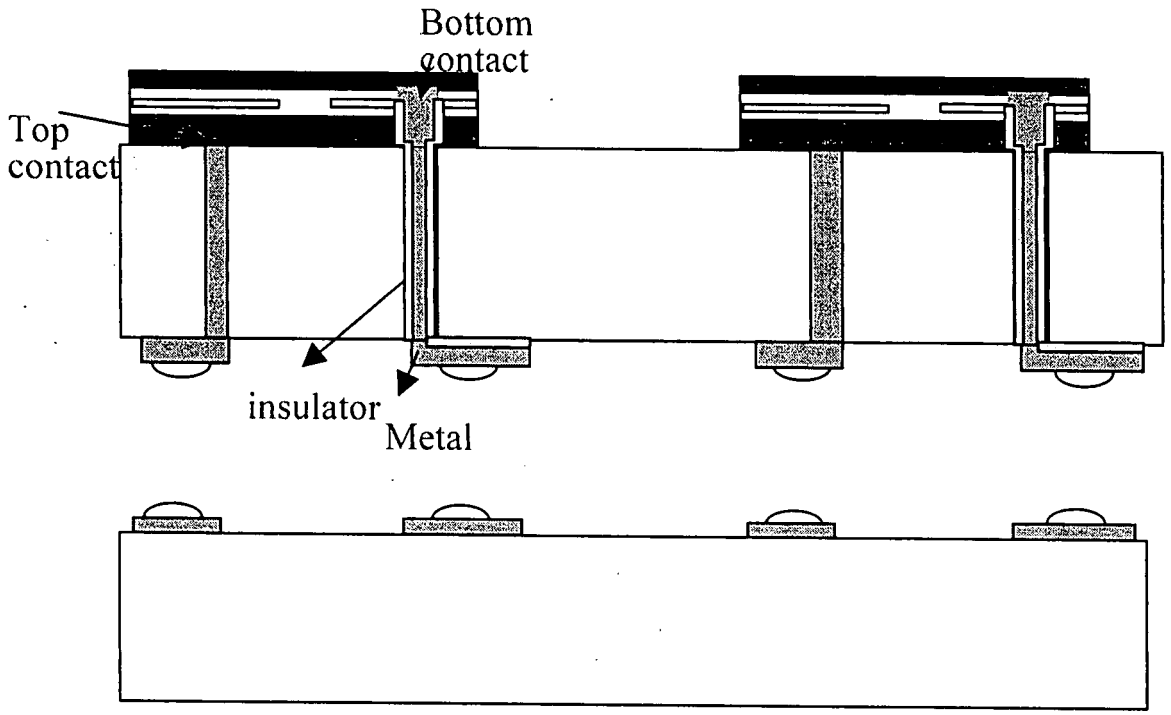
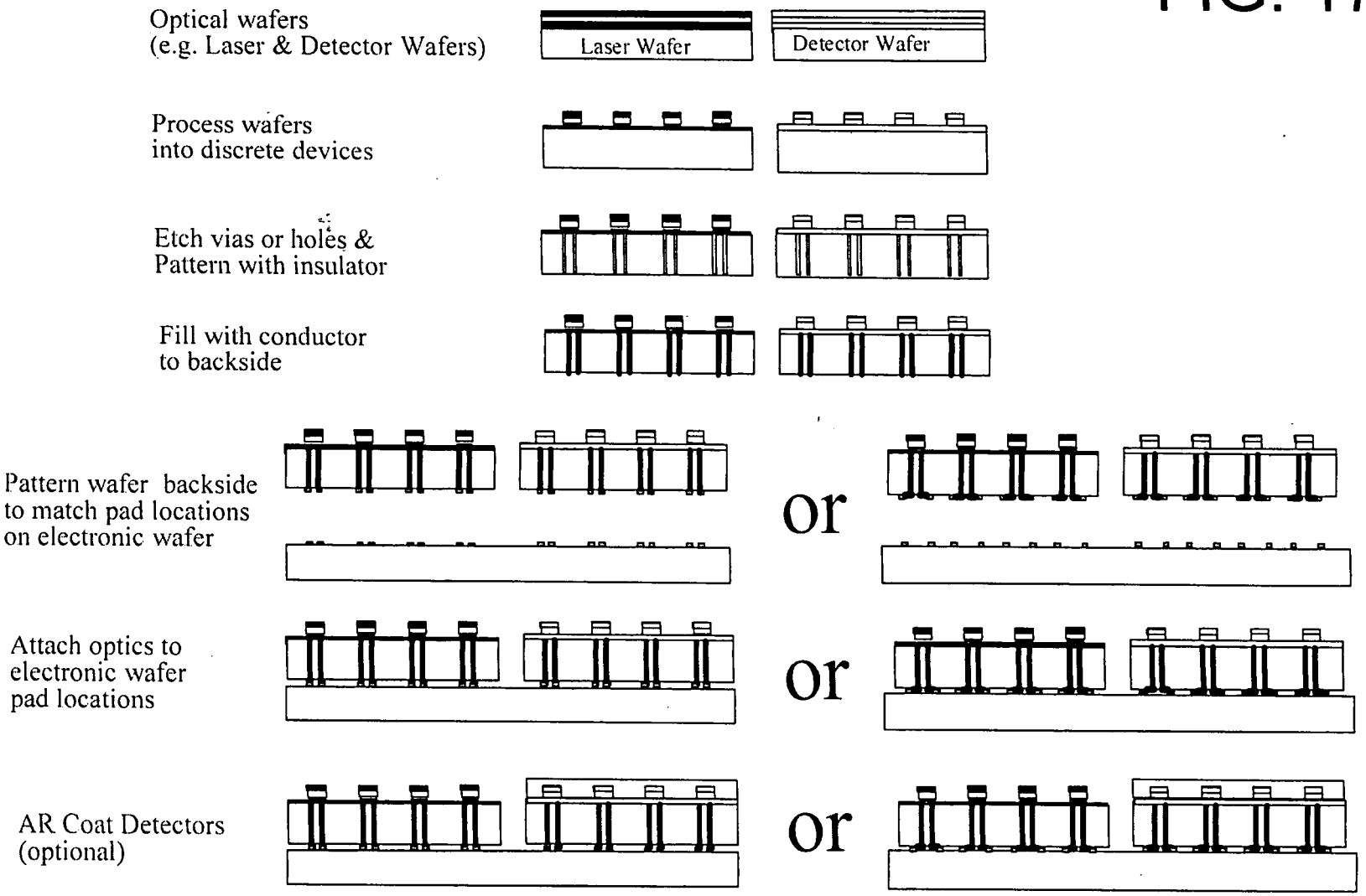


FIG. 16D

FIG. 17


Optical wafers
(e.g. Laser & Detector Wafers)
Laser Wafer
Detector Wafer
Process wafers
into discrete devices
Etch vias or holes &
Pattern with insulator
Fill with conductor
to backside
Pattern wafer backside
to match pad locations
on electronic wafer
or
Attach optics to
electronic wafer
pad locations
or
AR Coat Detectors
(optional)
or

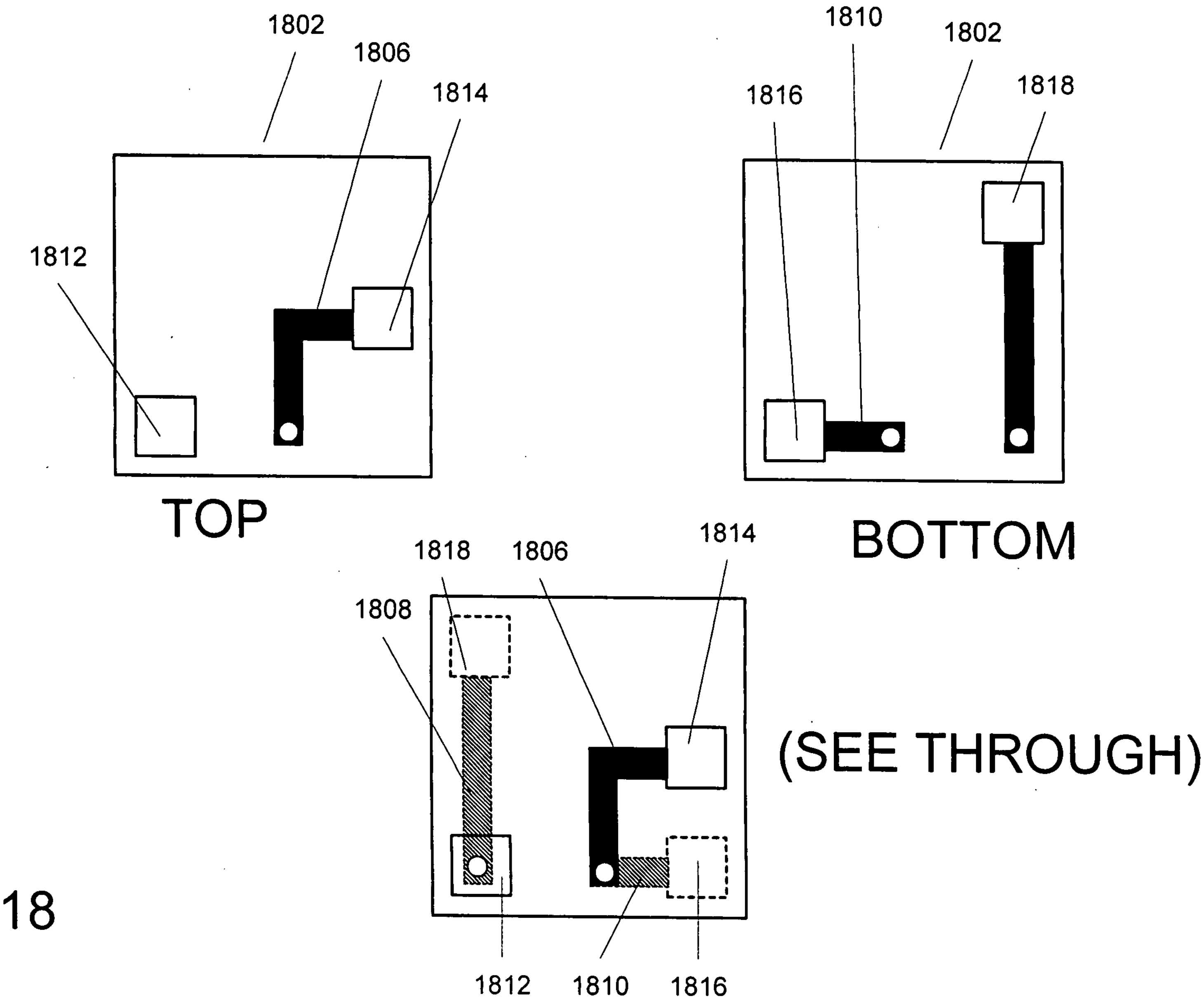
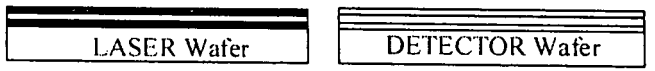
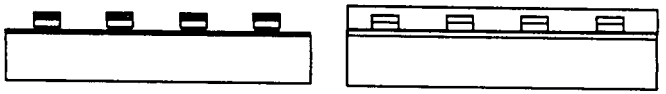

1802
1806
1814
1812
TOP
1810
1802
1816
1818
BOTTOM
1818
1806
1814
1808
(SEE THROUGH)
1812
1810
1816

FIG. 18

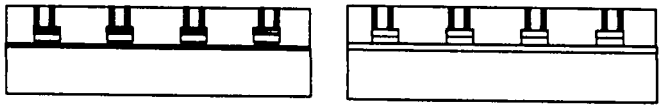
Optical wafers
(e.g Laser & Detector wafers)



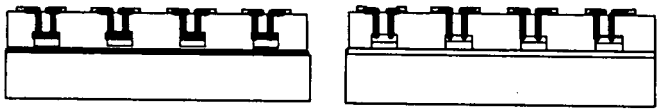
Process into individual devices
& AR coat detectors



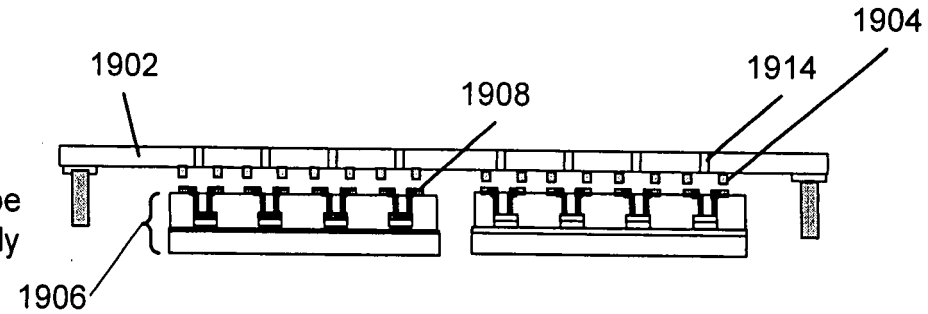
Cover devices with insulator and
pattern vias through to device
contact pads



Pattern optical device wafer
to create traces to locations
that will match mating
contacts on adapter



Attach optical device chip
to adapter via aligning
pads created by patterning
(NOTE: Holes in adapter can be
created pre-post or concurrently
with wafer patterning



Integrate adapter chip with
electronic chip via standoffs,
wires, etc.

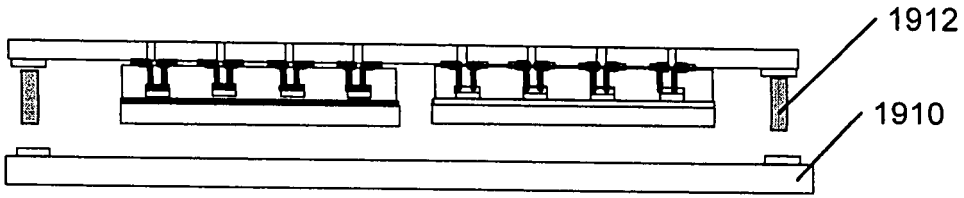


FIG. 19

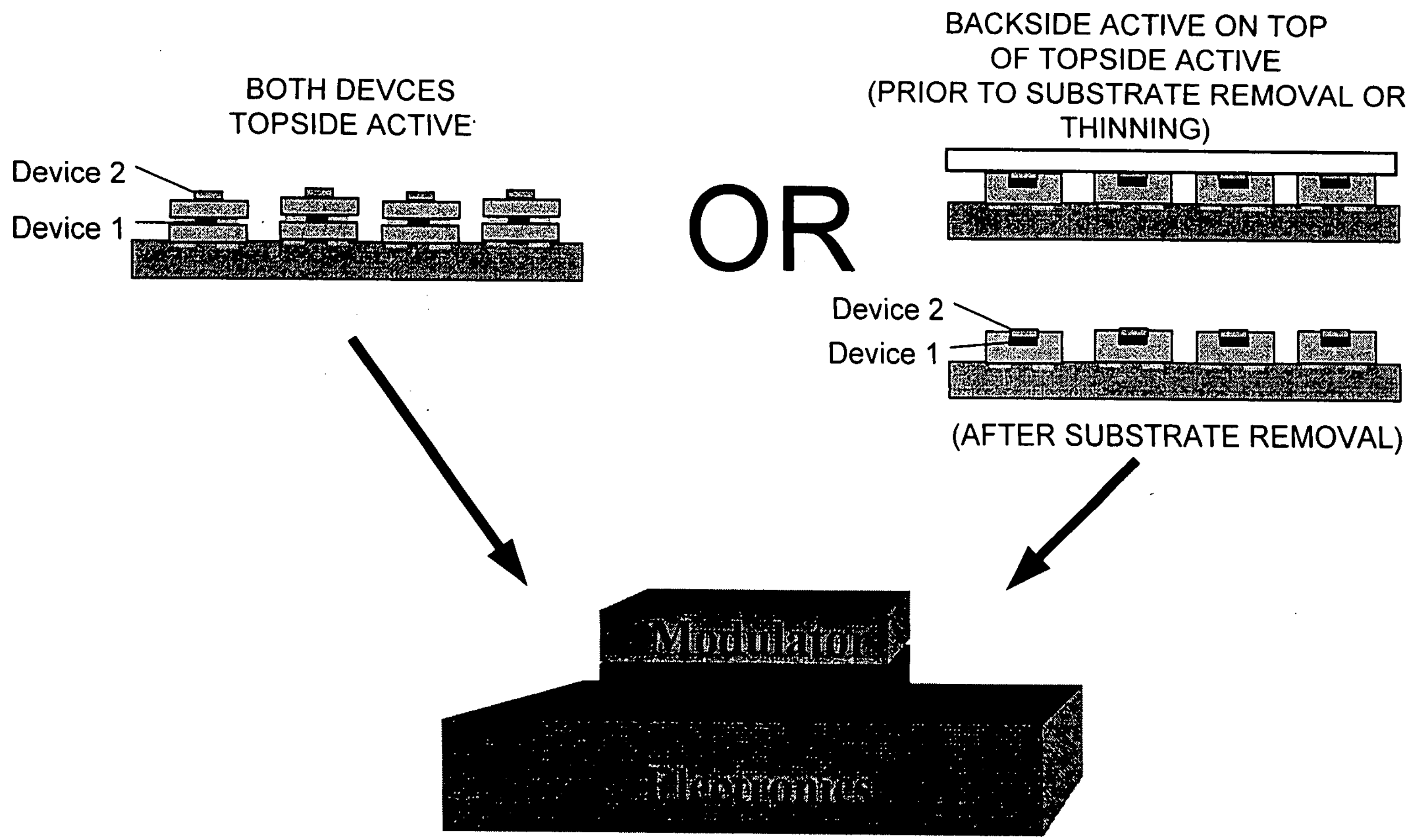

BOTH DEVCES
TOPSIDE ACTIVE
Device 2
Device 1
OR
BACKSIDE ACTIVE ON TOP
OF TOPSIDE ACTIVE
(PRIOR TO SUBSTRATE REMOVAL OR
THINNING)
Device 2
Device 1
(AFTER SUBSTRATE REMOVAL)
Modulator
Electronics

FIG. 20A

40 Gb/s = 20 GHz = 50ps
Wavelength in free space = 3 X 10^{10} cm/s * 50^{12}s = 1.5cm
1/8 wavelength in n=3 = 640 microns

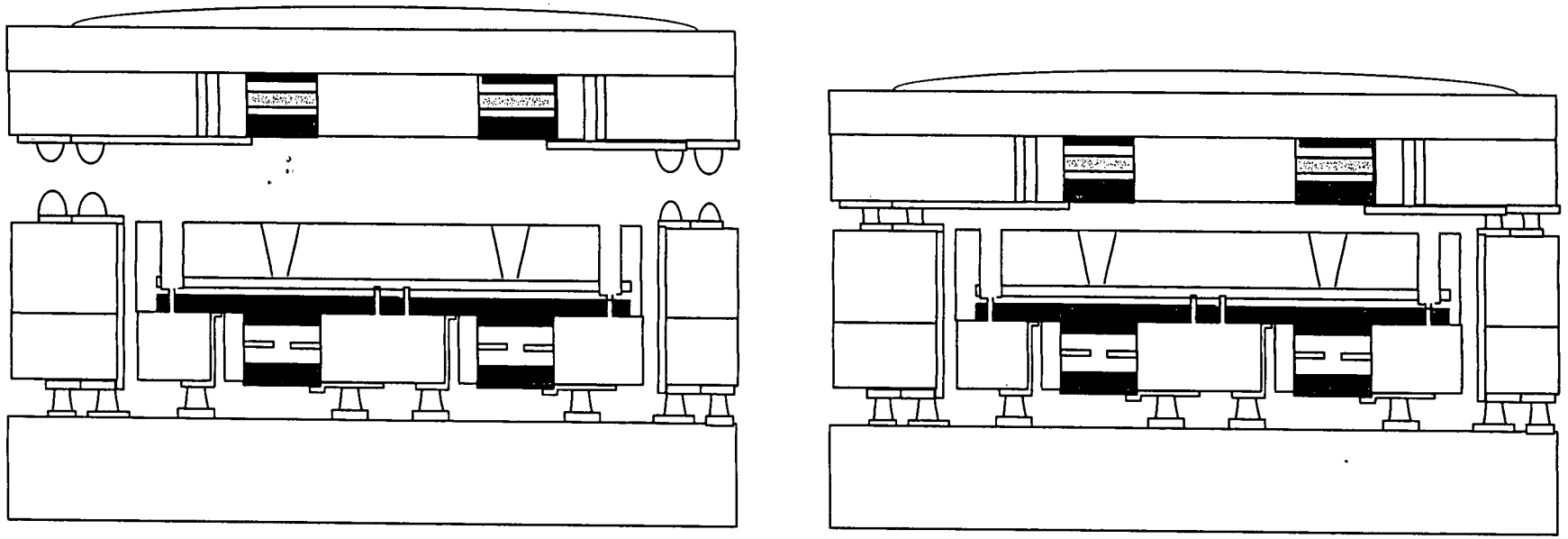


FIG. 20B

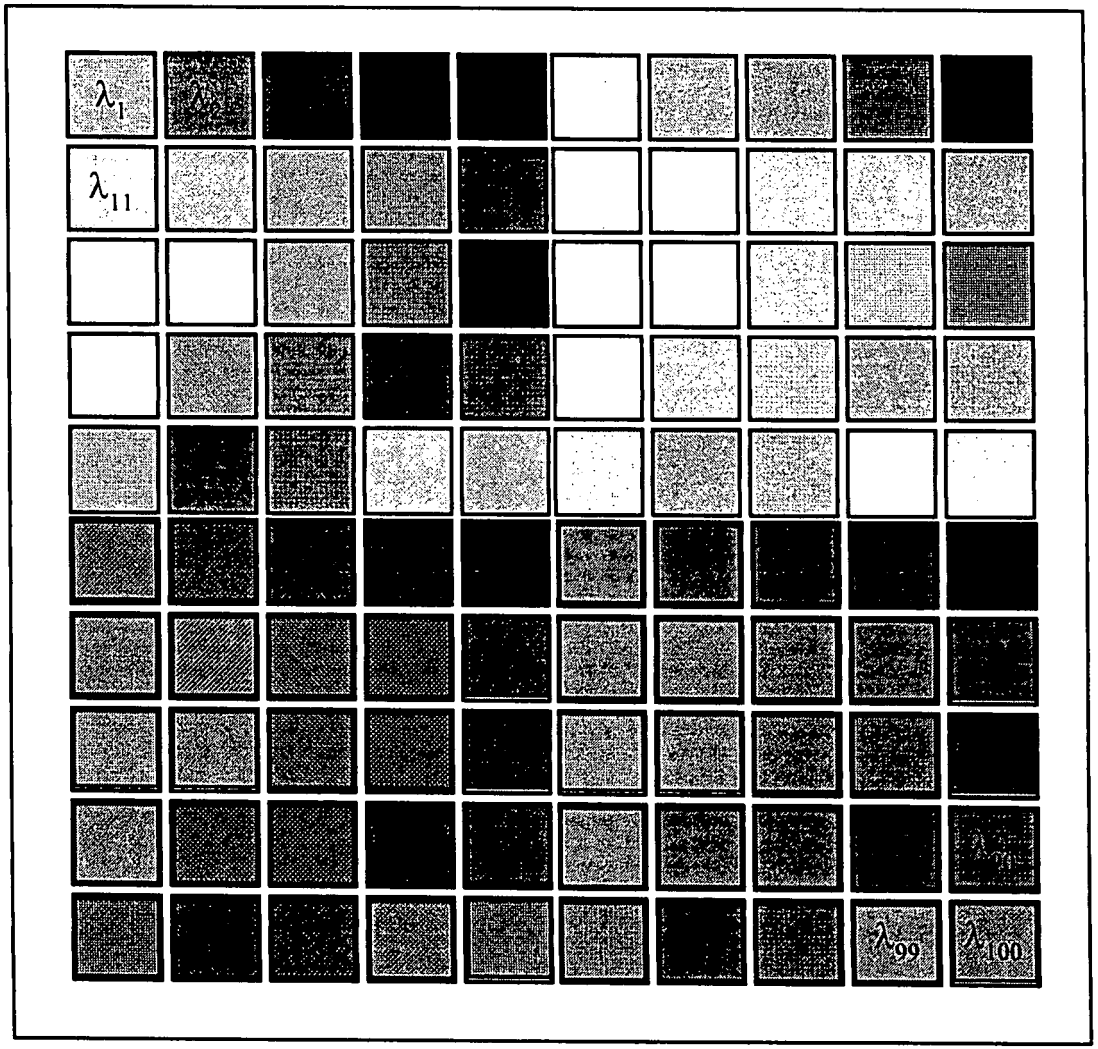


FIG. 21

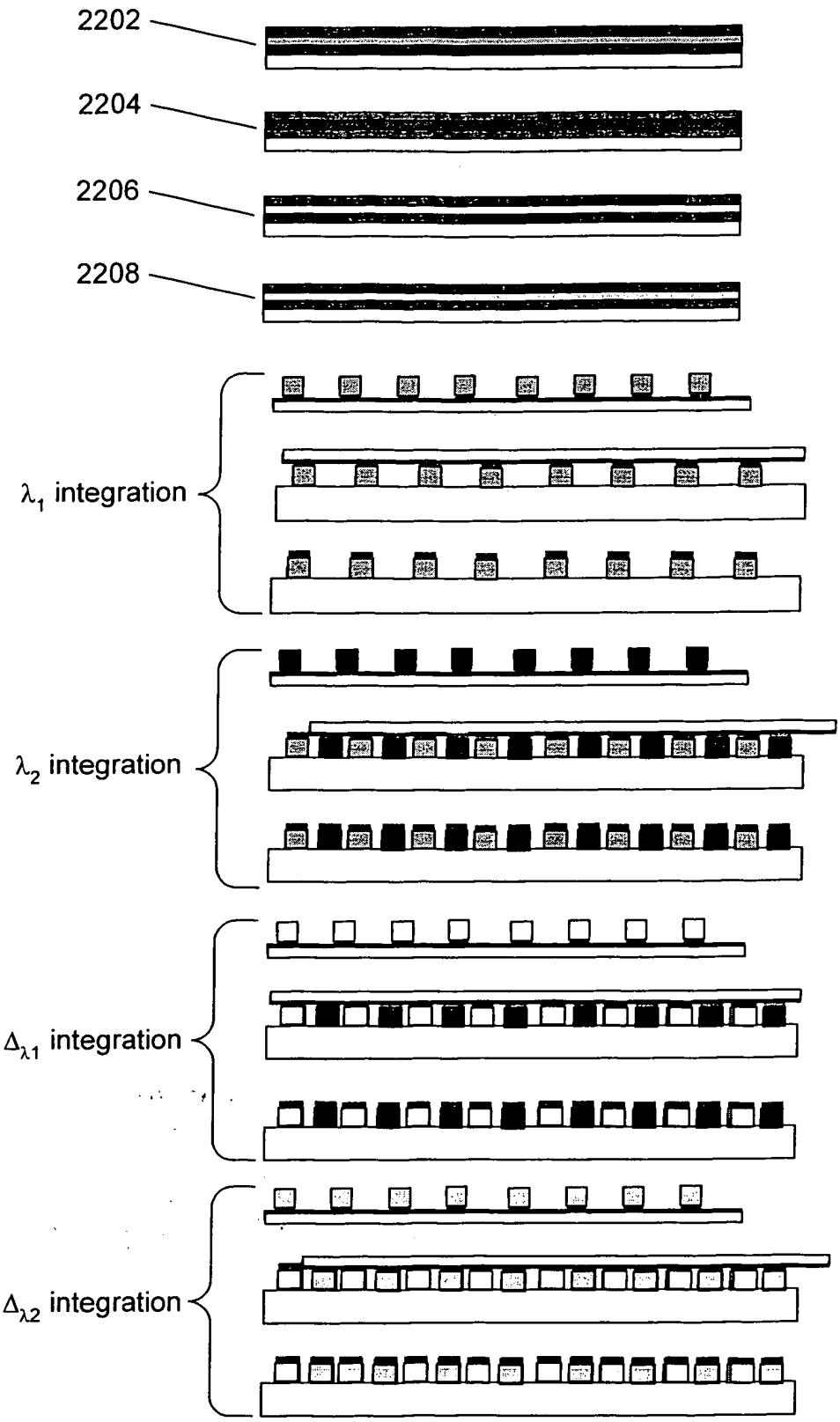

2202
2204
2206
2208
λ_1 integration
λ_2 integration
$\Delta_{\lambda 1}$ integration
$\Delta_{\lambda 2}$ integration

FIG. 22

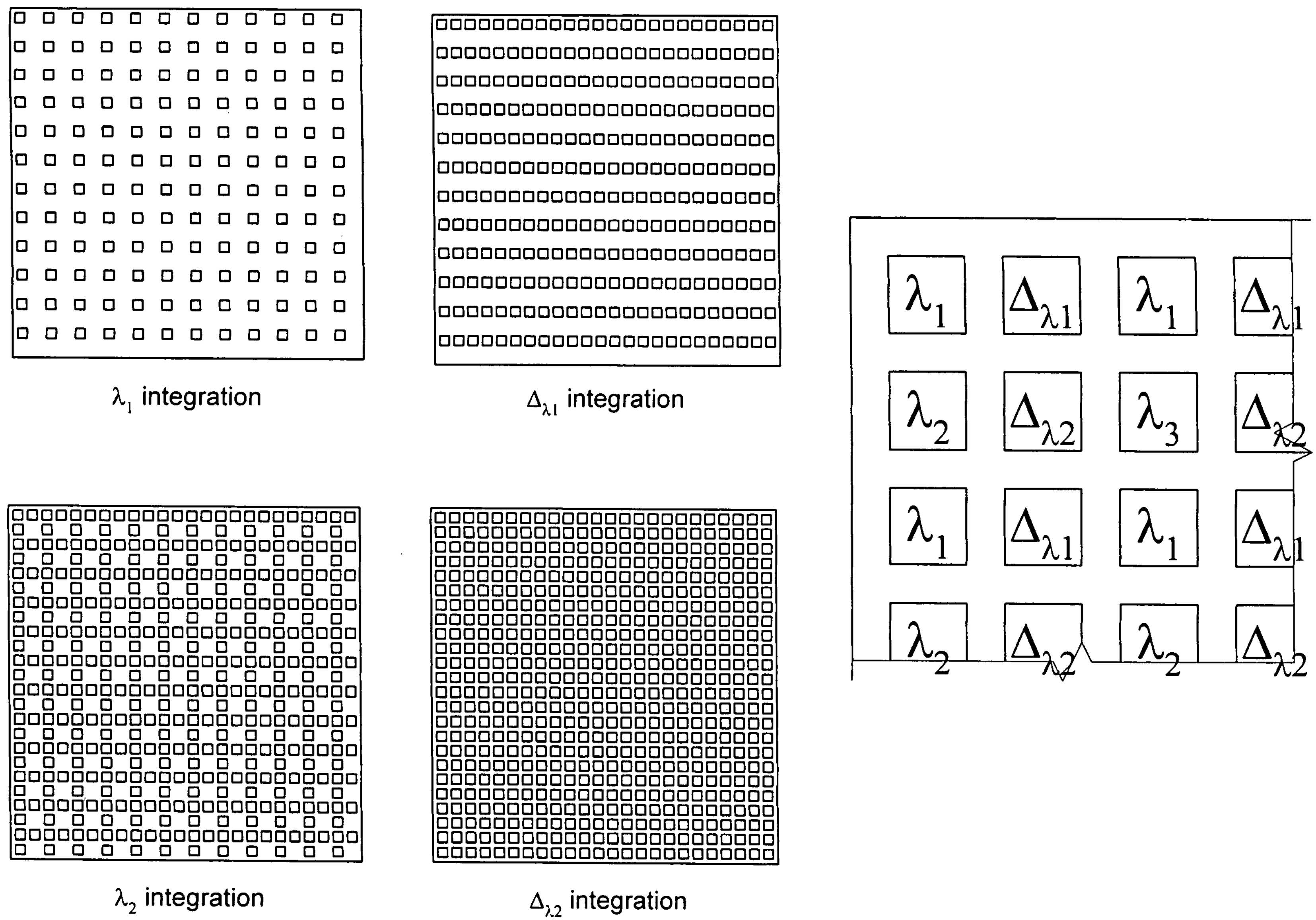

λ_1 integration
$\Delta_{\lambda 1}$ integration
λ_2 integration
$\Delta_{\lambda 2}$ integration
λ_1
$\Delta_{\lambda 1}$
λ_2
$\Delta_{\lambda 2}$
λ_3

FIG. 23